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Describes the results of pilot testing a new wildfire effects appraisal system in Wisconsin.

KEY WORDS: Economic values, fire management, valuation procedures, fire damage, fire benefits.

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PILOT TESTING A NEW SYSTEM FOR APPRAISING WILDFIRE EFFECTS IN WISCONSIN

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In Wisconsin, wildland fire damage appraisals conducted by Department of Natural Resources (DNR) foresters are frequently used in insurance settlements and legal proceedings. Using their old fire damage appraisal system, developed in 1938, fire management officials called upon for court testimony were often embarrassed by the poorly supported values that the system yielded. The old system had severe limitations for appraising immature timber stands, particularly plantations. Another problem was the arbitrary assignment of $1 of loss per acre for recreation and wildfire and another $1 loss per acre for site deterioration. No specific instructions were provided for appraising damage to crops, equipment and improvements, ornamental trees, aesthetics, environmental quality, or developed recreation.

Recognizing these shortcomings, the Wisconsin DNR, in conjunction with the North Central Forest Experiment Station and Michigan State University, developed an improved system. The primary purpose of the new system is to provide consistent and accurate wildfire effects appraisal information that would be defensible in court. The system was designed to be reasonably simple, to take no more than 1 hour to complete for an average fire, and to make the best possible use of currently existing Wisconsin data.

A tentative draft of the new system was completed in 1979. In 1980 a selected group of Wisconsin DNR foresters was trained to use the new system. During the 1980 and 1981 fire seasons they used both the old and the new systems to estimate the economic effects of a sample of Wisconsin fires.[1]

This report first compares the values obtained with each system and then describes the problems encountered during field testing and subsequent evaluations.

[1]*A detailed handbook, available from the North Central Forest Experiment Station, describes step by step field data collection and office calculation procedures for the new system.*

COMPARING THE OLD AND NEW SYSTEMS

The Sample

A total of 611 fires was included in the sample. They occurred in 21 counties selected to represent the full range of Wisconsin cover types. These fires burned a total of about 3,002 acres for an average of 4.9 acres per fire. However, excluding one large fire (1,028 acres), total acreage burned was only 1,974 or an average of 3.2 acres per fire. Only 50 of the other fires exceeded 10 acres, and only 7 exceeded 50 acres. The number of fires affecting various cover types were:

Cover type	Fires (Number)
Red pine	34
Jack pine	21
Aspen	17
White birch	4
Northern hardwoods	33
Other timber	35
Open field	384
Marsh	26
Crop	61

Resource Elements

The new system includes the following seven resource elements or value components:

Timber
Wildlife
Recreation
Ornamental trees
Environmental quality
Crops
Equipment and improvements.

Recreation is divided into effects on aesthetics and effects on developed recreation sites. Effects on undeveloped recreation are incorporated into the wildlife element. Because the primary purpose of the system is to ensure credibility in court, value changes

for most of the resource elements are expressed in terms of their impact on individual owners. Value changes for wildlife, aesthetics, and environmental quality, however, are expressed in terms of the impact on the general public because landowners cannot capture all of the value of these elements.

Timber

The new appraisal system for timber values differs from the old in several ways. One difference is that the old system defined the cover type as the prevailing species. Volume and value of affected trees were then estimated from tables based on pure stands of the prevailing species. The new system estimates volume and value of affected trees from tables based on the average mix of species found in a predominant cover type in various districts of Wisconsin. Another difference is in the estimation of tree mortality. The old system judged the degree of tree mortality for each burn as light (50 percent mortality), moderate (75 percent) or severe (100 percent). The new system estimates tree mortality as a function of the percent of crown scorched (for conifers) or the height of bark scorched (for immature and merchantable hardwoods), and can be expressed as any percentage between 0 and 100. Another major difference in the systems is that the old estimates current value for merchantable stands and discounts immature stands from the projected value they would have at optimum rotation age. The new system also estimates the current value for merchantable trees but for immature timber the harvest date is assumed to be the date at which the trees will first become merchantable rather than the "optimum" rotation age. Using this shorter period reduces prediction problems as well as the importance of the choice of discount rate.

Of the 611 fires included in the sample, 204 had an impact on timber. The new system produced consistently lower values for timber, an average of $41.77 per acre, compared to $70.00 per acre using the old system. This difference results from the old system's provision of assigning an arbitrary mortality estimate of 50 percent for a light burn, 75 percent for a moderate burn, and 100 percent for a severe burn. The average mortality estimate for light burns obtained with the continuous mortality function of the new system was 30 percent for light burns, 41 percent for moderate, and 66 percent for severe. Thus, overall values for all timber were lower with the new system even though it tended to produce higher values for immature timber damage due to the assumption that timber would be harvested when it first became merchantable rather than at optimum rotation age.

Wildlife

In contrast to the old system that arbitrarily assigned a wildlife value loss of $1 per acre burned, the new system provided a method to estimate the variable economic impact of fires on wildlife. While recognizing that wildlife is valuable for many non-economic reasons, the new system assumes that most of the economic value is associated with outdoor recreation, primarily hunting for game species. Fish are usually unaffected by wildfire in Wisconsin.

If a sample fire occurred in a cover type important to deer, small game, or waterfowl, the economic loss and/or benefit was estimated using the basic formula:

loss or benefit = use change x wildlife loss or benefit factor.

Use change is a function of tree mortality and the size of the burned area. Wildlife loss and benefit factors were developed for each county in Wisconsin. An example of loss and benefit factors from the southern region of Wisconsin is given in table 1. Each factor is the product of the success index for a particular species and county, the average expenditure for a day spent hunting that species, and the full effect of the fire on game populations. Generally, the success index is a ratio of use per acre in a county to the average use per acre in Wisconsin. Thus, a success index of one indicates average use, while a two indicates twice the average use. Estimates of the 1982 value of a user day based on hunter expenditures (National Analysts 1975) were $38.06 for deer hunters, $11.49 for small game hunters, and $20.61 for waterfowl hunters. The full effect for timbered areas is the change in game population expected if all trees were killed. The full effect is also assumed for open fields.

Benefits to white-tailed deer (in the form of increased browse) accrue when fires occur in white birch and northern hardwood stands or in jack pine and red pine plantations. Losses occur when the fire is in a spruce-fir, black spruce, tamarack, or cedar type. Fire effects on small game species (rabbit, pheasant, grouse) are primarily beneficial and result from fires in black spruce, white birch, aspen, jack pine, and open fields. Waterfowl benefit from fires in marshes or open fields within one-quarter mile of water, but are harmed if the fire occurs during the nesting season between April 15 and July 31.

Of the 611 fires included in the sample, 345 burned cover types important to wildlife and thus had an economic impact. Of these fires, 22 had an impact on deer, 273 on small game, and 250 on waterfowl.

Table 1.—*Wildlife loss and benefit factors in Wisconsin*

(In dollars/acres)

Region and County	Deer		Small game			Waterfowl	
	Benefit	Loss	BS,WB	A, JP	Open field	Benefit	Loss
Southern							
Columbia	308.71	214.38	2.60	1.98	12.21	15.52	3.10
Dane	58.80	34.12	6.64	10.34	6.99	5.57	1.11
Dodge	9.60	11.37	2.49	14.02	24.67	36.76	7.35
Fond du Lac	8.80	34.12	2.49	14.02	24.67	36.76	7.35
Grant	19.60	11.37	1.02	1.98		3.60	.67
Green	19.60	11.37	12.49	14.02	24.67	1.04	.21
Green Lake	308.71	214.38	6.64	6.94	24.67	36.76	7.35
Iowa	214.39	124.41	1.02	4.35	2.76	3.60	.67
Jefferson	19.60	11.37	6.64	6.94	12.21	36.76	.38
Lafayette	19.60	11.37	12.49	14.02	12.21	1.04	.21
Marquette	308.71	214.38	1.02	1.98		15.52	3.10
Richland	143.34	83.17	6.64	10.34		1.04	.21
Rock	19.60	11.37	25.47	29.08	24.67	5.57	1.11
Sauk	214.39	124.41	6.64	6.94		3.60	.67

Beneficial impacts resulted on 342 of these fires and losses (primarily for waterfowl) occurred on 144. The net economic effect of the fire was beneficial on 341 of the 345 fires and a net loss occurred on only 4. The average net benefit per acre burned was $8.86 for deer, $5.56 for waterfowl, $3.63 for small game, and $7.31 for all wildlife. This represents a sharp contrast from the $1 per acre loss used for all fires with the old system.

Recreation

No specific instructions were provided in the old appraisal system for estimating the economic impact of wildfire on developed recreation sites. The new system is based on an estimate of the number of visitor groups that would have used a fire-damaged recreation site during the remainder of the season (from time of fire to December 31) and the value per visitor group day for various recreational activities. Based on a Wisconsin DNR survey of expenditures in 1969 and inflated to 1982 dollars, the values used were:

Sightseeing —	$35.57
Camping —	33.85
Fishing —	31.61
Picknicking —	25.88
Boating —	21.36
Hiking —	20.50
Swimming —	14.42

None of the 611 fires included in the sample had an economic impact on developed recreation sites.

Aesthetics

Although no attempt was made to put dollar values on the effects of wildfire on aesthetics, the new Wisconsin system provides a consistent procedure to determine the relative impact. Variables influencing the aesthetic effect are the size of the area burned, the aesthetic importance of the area, and the intensity and duration of the effect. Five recreation use classes were identified to rate the relative aesthetic importance of the burned area.

One criterion for selecting the appropriate use class is the type of road from which the burned site can be seen. The highest category is a site visible from a four-lane highway while the lowest category is a site that cannot be seen from any road. A second criterion is the general recreational use of an area from which the fire site is visible. Lakes with public access and developed sites such as campgrounds and picnic areas are in the highest category. The lowest category is used for burned areas that cannot be seen from any road, trail, lake, or stream.

The intensity and duration of the fire's effect is assumed to be related to tree mortality, which is expressed in terms of four categories ranging from <25 to 100 percent. Aesthetic effects are rated as extreme, very heavy, heavy, moderate, light, or

negligible. Of the 611 sample fires, 521 had a negligible aesthetic impact, 46 were low, 29 were moderate, 13 high, 1 very high, and 1 large fire of more than 1,000 acres was rated extreme.

Ornamentals

Many Wisconsin wildfires occur near residences or developed recreation sites where they damage ornamental trees. Because ornamentals are not sold as timber, it is not appropriate to appraise them on the basis of timber values as was done with the old system.

The new system appraises small trees and shrubs at nursery replacement costs. The value of each large tree or group of similar trees is estimated using the following formula: value = base value x species factor x condition factor x location factor. This formula was developed by the International Shade Tree Conference in 1969 (Michigan Forestry and Park Association 1978). The base value used in Wisconsin is $19.81 per square inch. This value is obtained from $9.00 per square inch determined at the International Shade Tree Conference in 1969, inflated to 1982 dollars. The species factors assign each species a factor of 0.25, 0.50, 0.75, or 1.0 according to its desirability as an ornamental. The condition factor is a relative rating, between zero and one, of the prefire health, form, and vigor of the affected tree. The location factor is an assessment of the importance of the ornamental tree in the landscape, ranging from one for a single specimen on a key site to near zero for one of a group of trees at the forest edge of a developed site. All trees must be visible from and within 100 yards of a lake, home, or developed recreation site to be considered ornamentals.

Of the 611 sample fires, 36 damaged a total of 1,160 ornamental trees with an average damage of $51.45 per tree, or $1,658 per fire affecting ornamentals. This figure is much higher than the insignificant one obtained by using the old system and shows that ornamental trees are an important component of wildland fire damage in Wisconsin.

Environmental Values

Wisconsin data indicate that water quality and soil stability are rarely significantly affected by a single fire. However, air quality can be affected by smoke, but was not considered in the old system. Although no dollar value is assigned, the new system employs a method to estimate the relative importance of smoke on air quality.

The method requires determining atmospheric stability (stable or unstable), a smoke index, and a population use class. The smoke index is based both on the size of the fire and the duration of the smoke. Thus a small but long-burning peat fire might produce a higher smoke index than a large grass fire. Five population use classes were identified to rate the importance of use areas affected by the smoke. The classes generally depend on the size of the city or town in which the smoke can be detected, although highway size and recreation use can also influence the classification. The effects are rated as extreme, severe, heavy, moderate, light, or negligible. Of the 611 sample fires, 324 had negligible impacts on air quality, 204 had light impacts, 72 had moderate, and only 11 were heavy.

Crops

The old system contained no instructions for estimating wildfire damage to crops. With the new system, the loss of a crop is simply the net value of the expected yield (as estimated by county agents). If the burned crop can be replanted in the current year, the loss is the sum of the replanting cost and the value of the reduction in the expected yield (the replanted crop would probably have a reduced yield due to a shorter growing season). In either case the following equation can be used:

$$\text{crop loss} = \text{replanting cost} \times \text{acres burned} + \text{yield loss} \times \text{price} \times \text{acres burned}.$$

If a crop cannot be replanted in the current year, the replanting cost is zero.

Of the 611 sample fires, 61 burned a total of 225 acres of cropland (mostly hay) and did an average damage of $9.49 per acre of cropland burned.

Equipment and Improvements

In contrast to the old system that contained no specific instructions for estimating damage to equipment and improvements the new system estimates the cost to replace destroyed items or to restore a damaged item to its prefire condition. Foresters in the field decide which items require repair or replacement and estimate their prefire condition. The cost of the repair or replacement is determined in the office after consulting blue books, contractors, or equipment dealers.

Of the 611 sample fires, 71 resulted in damage to equipment or improvements. The average damage for these fires was $826.44 but this average was greatly

raised by one fire that caused nearly $20,000 worth of damage to equipment and improvements. Without that fire, the average damage was $570.03. Like ornamentals, equipment and improvement losses can be an important component of the total net value change of a fire.

PROBLEMS WITH THE NEW SYSTEM

Each Wisconsin DNR forester who used the old and the new system in the sample of 1980 and 1981 Wisconsin fires was asked to evaluate the new system and discuss the need for changes and improvements. Although these foresters were pleased with the new system and all thought that it was a great improvement over the old, they had several problems in using it.

Tree Mortality Equations and Graphs

The new system's tree mortality estimation equations and graphs, developed by Gorte (1981), were tested during the Wisconsin fire season of 1980. Users found that Gorte's equations performed well for Wisconsin conifers but not for hardwoods. Part of the problem was due to the difference in Wisconsin species and part due to the fact that Gorte's hardwood equations were only for merchantable and immature trees rather than for a full range of diameter classes. A study is underway to develop new hardwood mortality equations, based on variables that can be measured shortly after fires.

The participants were also concerned that the new system contained no provision for estimating volume and value losses for trees that were damaged but not killed, nor did it account directly for salvage values for dead and severely damaged trees. These problems are being addressed in studies by the North Central Forest Experiment Station.

Black Walnut, Christmas Trees, and Plantations

Trial participants pointed out that values obtained with the conventional timber methodology (based on the average mix of species in a timber type) were far too low for black walnut, Christmas trees, and plantations of conifers or black walnut. In several cases the values obtained for plantations were lower than the replanting cost. These problems were resolved by developing a separate value table for black walnut and by assigning individual tree rather than volume per acre values to Christmas trees. For plantations, site preparation costs were included in the loss calculation and replanting costs were reported although not included in the loss calculation. This represents an interim compromise because it is still debatable if either site preparation or replanting costs are a legitimate addition to the value loss. The fact that these costs sometimes exceeded discounted future market values may indicate that additional nonmarket values are incorporated in the decision to establish a plantation. Thus, the procedures for evaluating fire effects on plantations may be revised again.

Wildlife

Many who tried the new system were uncomfortable with the wildlife section. One general concern was that the values obtained with the new system (or any system) may not be accurate enough to be useful. Some felt that it is inherently wrong to try to put price tags on wildlife. Their reasoning paralleled that expressed by Leopold (1962). "One basic weakness in a conservation system based wholly on economic motives is that most members of the land community have no economic value. Wildflowers and songbirds are examples. Of the 22,000 higher plants and animals native to Wisconsin, it is doubtful whether more than 5 percent can be sold, fed, eaten, or otherwise put to economic use."

The wildlife effects appraisal procedures are based on only one of many fairly subjective approaches, none of which is universally accepted. The simplifying assumption that most of the economic value of wildlife is reflected in hunter expenditures seems necessary to develop any dollar figures at all, given the data available in Wisconsin. If the wildlife values obtained using the new system provide a consistent means of estimating the relative impact of different fires on wildlife, and the results are at least in the right direction in terms of benefits and damages, the new system is an improvement. Researchers generally agree that the physical effects of fire on wildlife in Wisconsin are variable but mostly beneficial. The results of using the new system reflect this, but the old assumes that effects are uniform and moderately harmful.

Specific problems mentioned by users involved the waterfowl calculation and the complexity of the calculations for small game. The instructions for the waterfowl calculation originally required the appraiser to make the calculation for all open fields and marsh lands within 1 mile of water. In Wisconsin nearly all of the sample fires involving open fields or marsh were within the 1-mile criterion. This criterion was therefore reduced to one-quarter mile on the advice of DNR wildlife biologists.

To reduce the complexity of the small game calculations, which were originally calculated individually

for pheasants, grouse, and rabbits, these were combined into one average factor for small game. The average benefits and losses for each county in Wisconsin were then pre-calculated and arranged in a table. The appraisers now have only to refer to the table if a fire occurred in a cover type important to wildlife.

Ornamentals

The trial participants experienced problems involving both very small and very large ornamental trees using the formula for ornamental trees developed by the International Shade Tree Conference (Michigan Forestry and Park Association 1978). For small trees, the values obtained were consistently lower than nursery replacement costs. For large trees the d.b.h.^{2} element in the formula resulted in unrealistically high incremental value increases when trees exceeded 14 inches in diameter. To correct these problems, the new system was changed to use nursery replacement costs for all small trees and shrubs, and the value for a 14 inch tree was assigned to all trees 14 inches and over.

Another problem occurred on several fires that damaged trees on undeveloped lots. The original instructions defined an ornamental tree in terms of its location in a yard within 100 feet of a home, or visible and within 100 feet of a developed recreation site. Users felt that the trees on undeveloped lots were more valuable than a timber estimate would indicate but less valuable than an ornamental tree (as defined above) estimate would indicate even if a minimum location class of 0.25 was used. The system was revised to allow classification of trees on undeveloped lots as ornamentals at the discretion of the appraiser and to allow him/her to assign a location class lower than 0.25.

Crops

Users experienced no problems in applying the new system to fires that damaged farm crops. They did feel, however, that a potential problem exists for crops that are not planted and harvested annually such as fruit and ginseng. It was decided, however, that this problem would not occur often enough to merit specific treatment in the new system other than assigning a space for foresters to describe any value changes not specifically covered by the instructions.

General

While testing the new system, users found many ways to streamline both the reporting forms and the instruction guidebook and make them easier to use. Several sections that required calculations were converted to tables or charts. An improved flow chart was designed to bypass sections not needed on a particular fire and to proceed through the appraisal as quickly as possible without retracing any steps.

SUMMARY

The new system provides a consistent and comprehensive methodology for appraising the full range of fire-related resource effects. It recognizes the beneficial effect of fires as well as the damages, and it utilizes the most current information available to estimate value changes. The cooperative development of the new system attempted to strike a balance between a theoretically correct system and one that is practical and easy to use. It represents a step forward in the evolution toward a complete and theoretically correct system and is flexible enough to accommodate changes as more current information becomes available. Although many of the inputs to the system, such as hunter success indices and timber types or prices, were used because of their availability in Wisconsin, similar data for many other Northeastern States are probably available and the basic format should be generally useful. Researchers in West Virginia are currently studying the adaptability of the Wisconsin system to that State.

Some problems with the system remain and others are likely to turn up as results of implementing the system statewide in 1982 are analyzed. Probably the most important problems are the uncertain accuracy of the tree mortality prediction equations in Wisconsin hardwood timber types and the lack of a method to estimate the value loss for trees injured by a fire. Researchers at the North Central Forest Experiment Station are developing improved mortality prediction equations and a method to predict the potential value loss for fire-injured trees.

LITERATURE CITED

Gorte, Ross W. Fire effects appraisal: the Wisconsin DNR example. East Lansing, MI: Michigan State University; 1981. 92 p. Dissertation.

Leopold, Aldo. A sand county almanac. 6th ed. New York: Oxford; 1962. 226 p.

Michigan Forestry and Park Association. Michigan tree evaluation guide. East Lansing, MI: Michigan State University, Department of Forestry; 1978. 19 p.

National Analysts. The 1975 national survey of hunting, fishing, and wildlife-associated recreation: Wisconsin. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service; 1975. 83 p.